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Low-sludge age EBPR process for resource recovery – microbial and biochemical process characterization

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1. INTRODUCTION

Current research promotes resource recovery using different strategies:

- Energy recovery using A-stage systems [1]
- Phosphorus recovery using low-SRT EBPR systems [2,3]
- To minimize nitrification, thus producing ammonium rich medium for phototrophic organisms [2]
- Water reuse for "fertigation" [2,4]

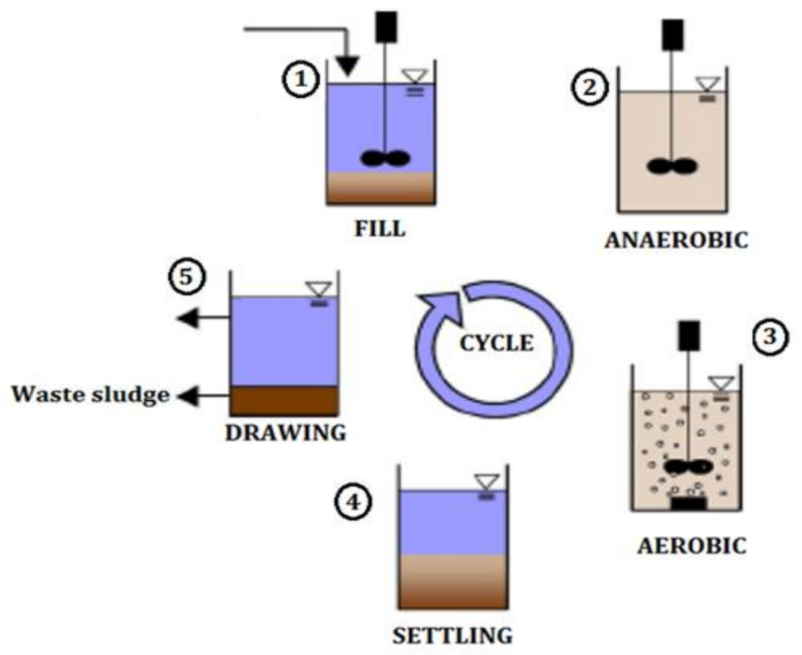
Common element: short-SRT EBPR systems

Optimal N-to-P ratio

Fertigation

2. OBJECTIVES

- To **start-up** a **short-SRT EBPR** system and describe **process performance**
- To **define** the **microbial community**, affecting the performance of the short-SRT EBPR system
- To quantify **energy recovery**



System: sequencing batch reactor fed with municipal wastewater

3. RESULTS

1. Process Performance:

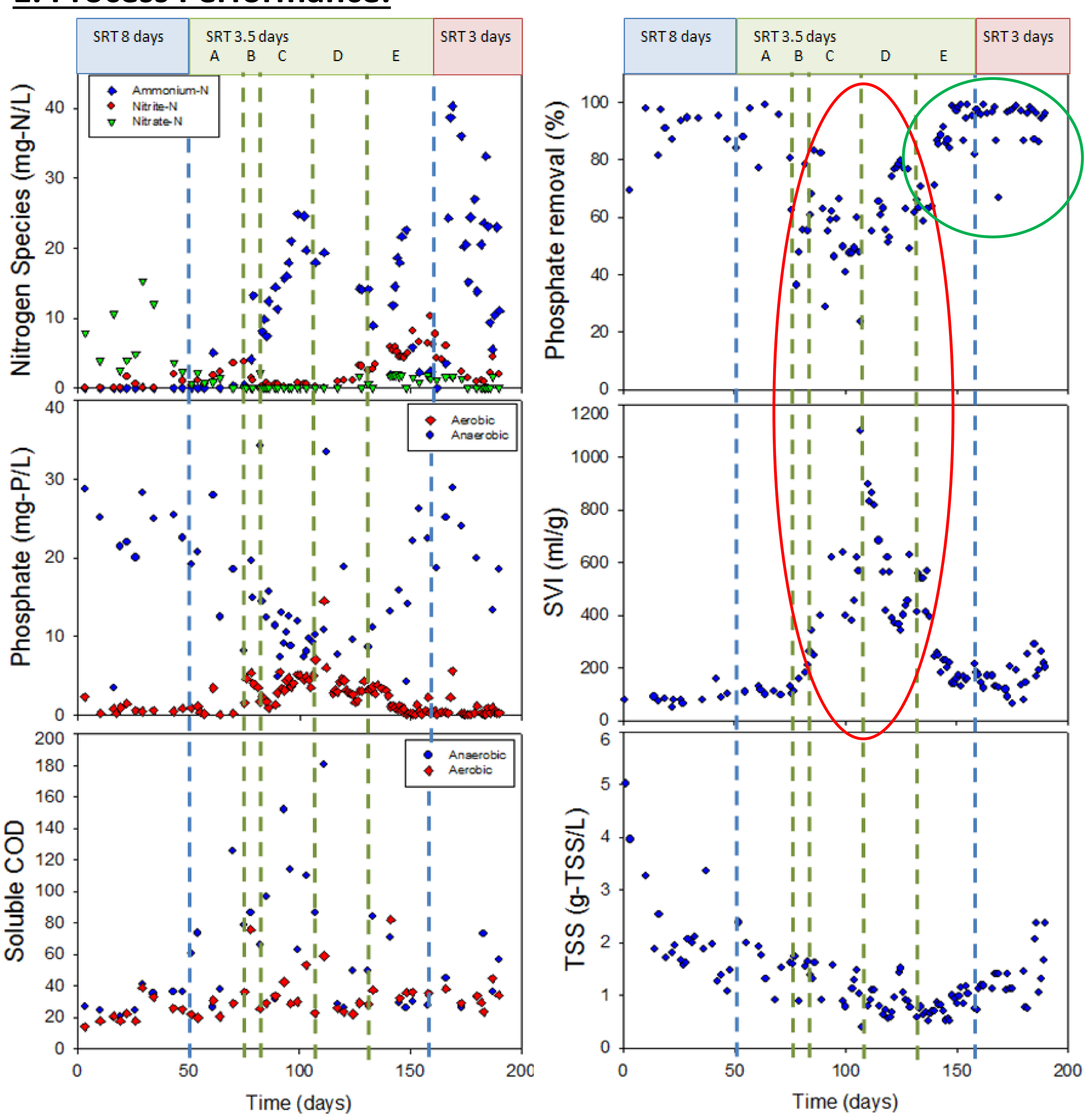


Figure 1: Reactor performance through 190 days a) Ammonia, nitrite and nitrate at the end of the aerobic phase and ammonia in the influent; b) phosphate at the end of the aerobic and anaerobic phases and influent; c) soluble COD at the end of the anaerobic and aerobic phases and total COD in the influent; d) phosphate removal; e) sludge volumetric index; f) total suspended solids. Phase A: from day 50 to day 78 – anaerobic SRT=1.2 d and aerobic SRT=1.75 d; phase B: from day 78 to 83 – anaerobic SRT=1.2 d and aerobic SRT=1.45 d; phase C: from day 83 to 109 – anaerobic SRT=1.2 d and aerobic SRT=1.75 d; phase D: from day 109 to day 132 – anaerobic SRT=0.88 d and aerobic SRT=1.75 d; phase E: from day 132 to day 156 – anaerobic SRT=0.68 d and aerobic SRT=1.75 d.

2. Microbial community:

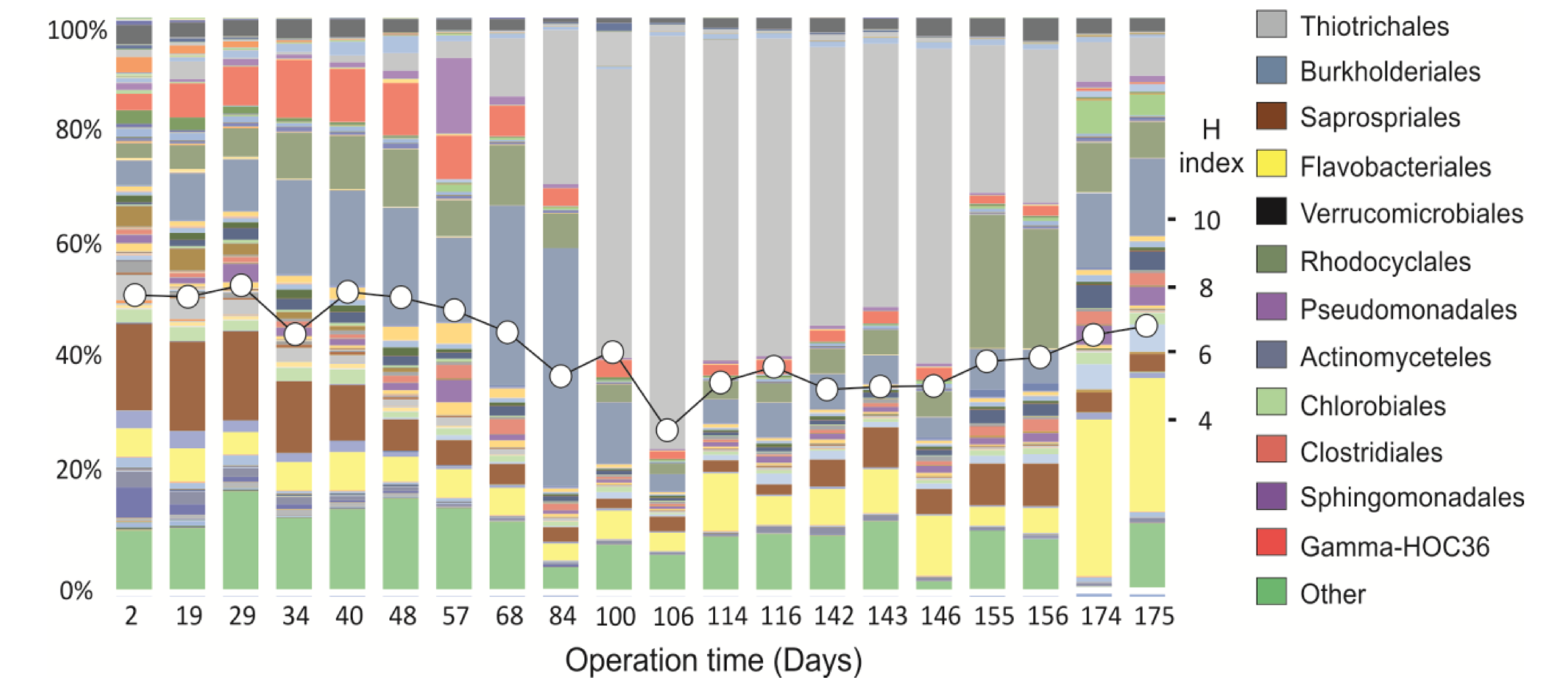
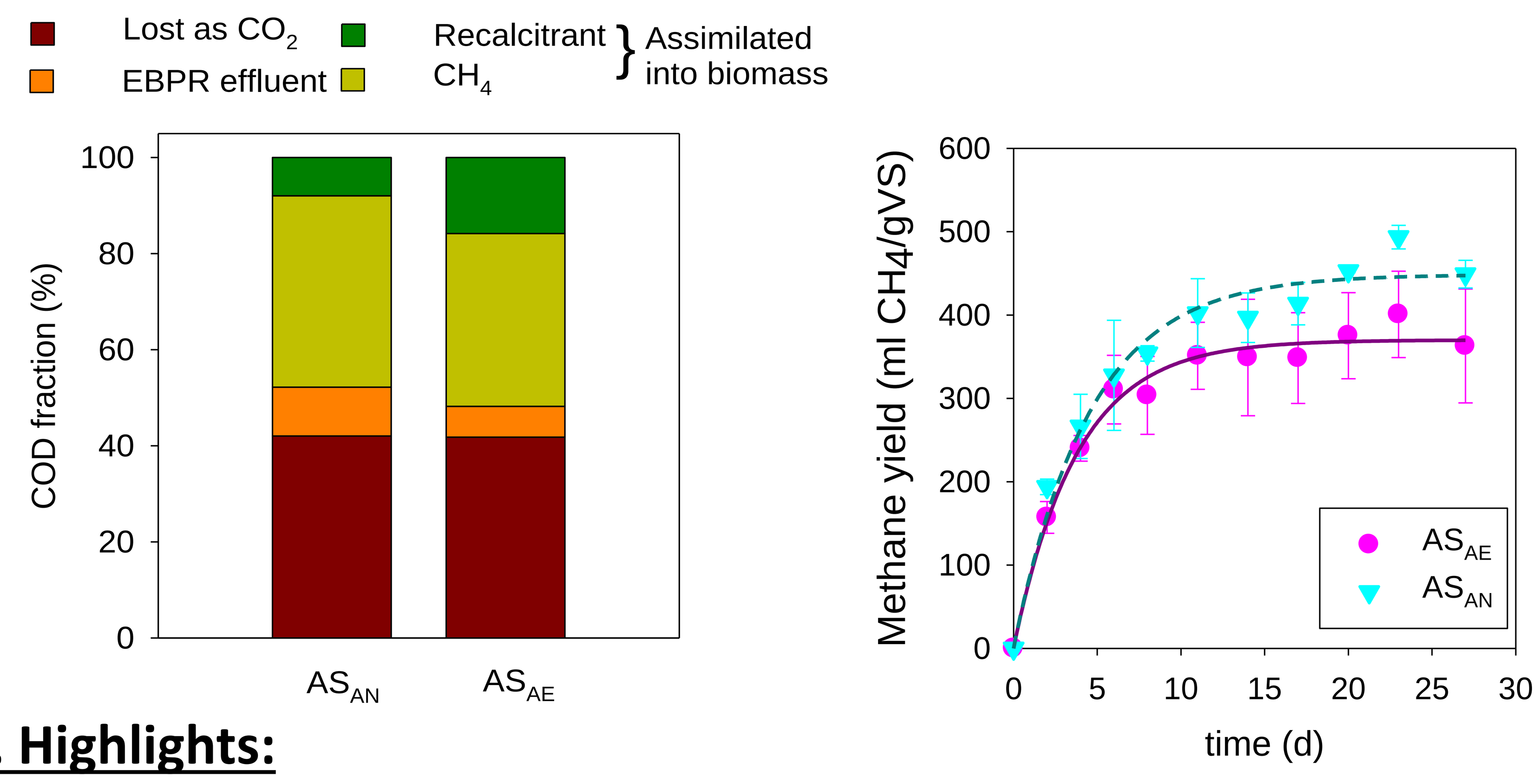


Figure 2: Order-level taxonomic classification of 16S rRNA amplicons at selected days of the reactor operation. Taxa abundance is expressed in percentage (left axis). Alpha-diversity at the order level measured as Shannon index (white dots, right axis).

3. Biomethane potential:



4. Highlights:

- EBPR effectively **removed phosphorus** at **SRT=3 d** and ***Accumulibacter phosphatis*** was the main PAO (based on qFISH)
- **Bulking** correlates with **poor phosphate removal** (highlighted in red, in Fig. 1)
  - **High abundance** of ***Thiothrix*** filamentous bacteria
  - **Sulfate reduction** during the anaerobic phase (about 30% of influent sulfate)
- **Sulfate reducers** outcompeted **PAO** by
  1. **Competing for influent COD**
  2. **Inhibiting phosphorus release**
- **Phosphate removal restored** by **reducing** the **anaerobic** phase length (highlighted in green in Fig. 1)
- Up to **40% of influent carbon** is **recovered** as methane at **SRT=3 d**

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DTU INWATECH KAIST

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